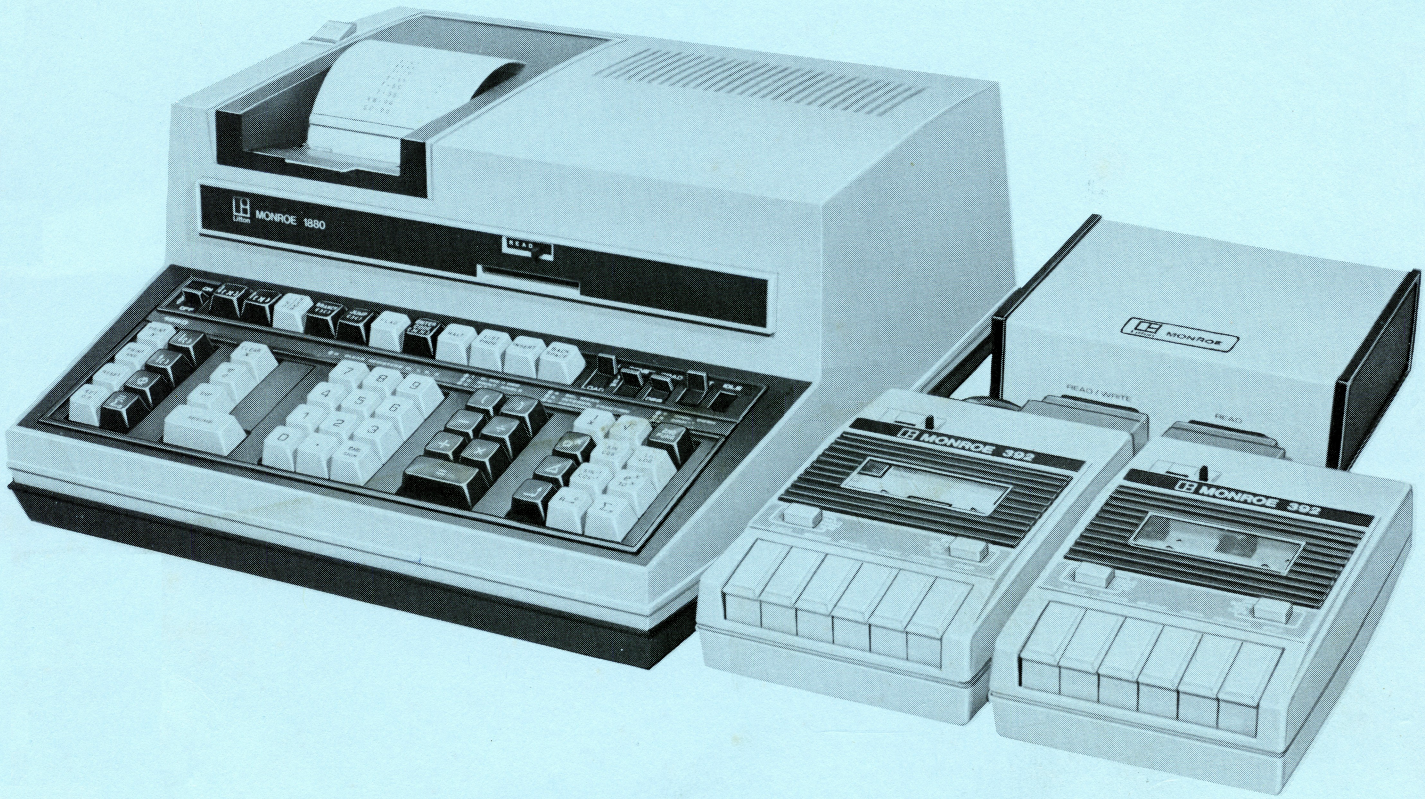
Litton MONROE

Model 392 Read/Write
TAPE CASSETTE DRIVE SYSTEM
for 1800 Series Calculators



Monroe, The Calculator Company

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IMPORTANT NOTES

1. Flag Group B is used by the software which controls the Model 392. Existing programs which use Flag Group B will require that the READY switch be unlatched during execution of the program, and that the Manual Operations idle loop be accessed (see Manual Operations) before the READY switch is again latched.

2. Monroe Operation Achievement cassettes can only be read with an Operation Achievement interface program supplied by your Monroe representative.

PREFACE

Tape cassettes have revolutionized not only audio and video products, but also computers. With the Monroe 392/1800 Cassette Drive System, 1800 Series programmable calculators are no longer limited in problem-solving capacity by the number of program steps or data registers that can be stored in the machine at any one time. Programs and data can be chained on tape and automatically called in sequence into memory when required.

Material in this manual has been grouped so that major topics are self contained and it is not necessary to read an entire chapter to extract one idea.

The index provided at the right of this page separates the tabbed information by chapter. Simply go to the height indicated by the tab on this page and then turn to the desired tab.

Manual operations are provided in this manual for the user who is not using Monroe prepared programs exclusively and wants to perform various cassette operations at the calculator keyboard.

Programmable operations are provided for the person who wants to write programs which will automatically execute cassette operations under program control.

A person who wants to write his own programs using the 392/1800 Cassette Drive System should be familiar with programming of the 1800 Series computers. Programming is described in the manuals for the various models.

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Chapter 1
INTRODUCTION

The Monroe 392 Tape Cassette Drive greatly increases the programming capability of your 1800 Series computer. Hundreds of blocks of program and data information may be stored on a cassette tape and recalled into memory when desired. You can write your own programs and record them on tapes or you may want Monroe to write a custom program tailored to your needs.

The tape drive may be connected to any Monroe 1800 Series computer (with appropriate memory) by means of a 392 Read/Write Interface unit. The interface unit has been designed to select and control one of three interface ports. The interface ports provide the following capabilities:

I/O – This port allows alphanumeric information to be input to or output from the computer through compatible I/O devices.

READ – This port allows only the reading of data or program steps into the computer. Thus, prepared programs or recorded data may be read into the computer, but programs and data may not be *recorded* on tape using this port. This port may also be connected to a Model 395 Teleprinter Interface which permits data from a Teleprinter to be read into the computer. The Model 395 has a port for a 392 Tape Drive so that two cassette tape drives may be connected along with the 395.

READ/WRITE – This port has all of the capabilities of the *Read* port with added capability of writing programs or data from the computer onto a cassette tape.

A sample configuration showing 392 Read/Write Interface capabilities is shown in Figure 1.

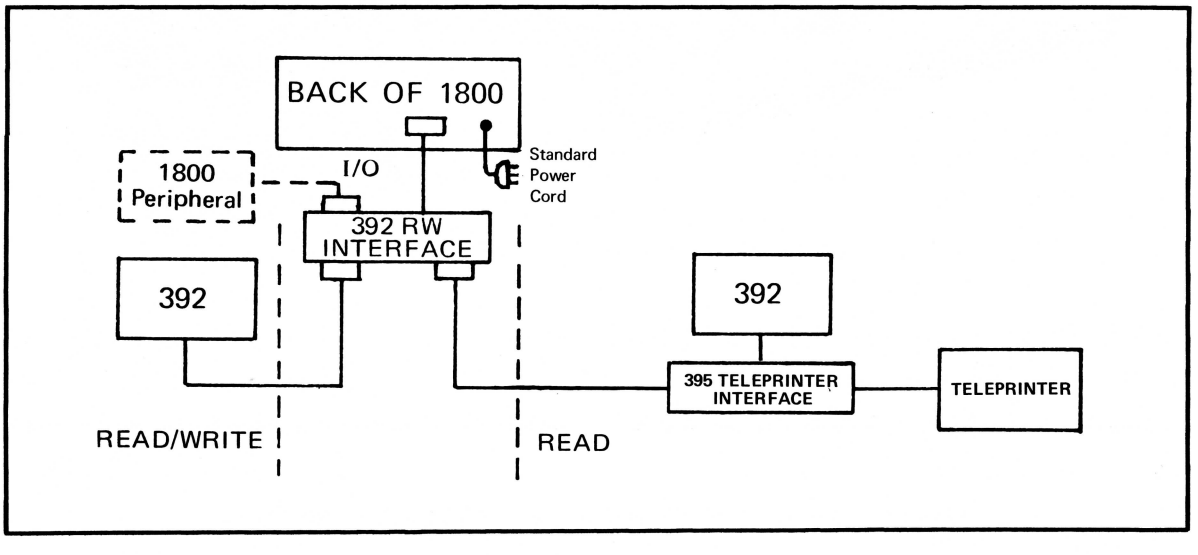


Figure 1 Sample Configuration Showing 392 Interface Capabilities

Reading and writing operations can be done with a single 392 cassette drive. However, using two drives makes updating information easier and tape duplication more convenient. (See Figure 2.)

Information is written on the cassette in blocks (of 256 steps or bytes) which are numbered sequentially. Data may also be stored on tape from the computer's data storage registers. Each block on the cassette can store the information contained in 32 data registers (each register holds eight bytes of data). The data to be written into a single block may be in any group of 32 sequentially numbered registers.

The read and write operations of the magnetic tape drive may be accomplished under program control. Therefore, writing programs and data onto magnetic tape and reading programs and data from the tape can be done automatically by a program.

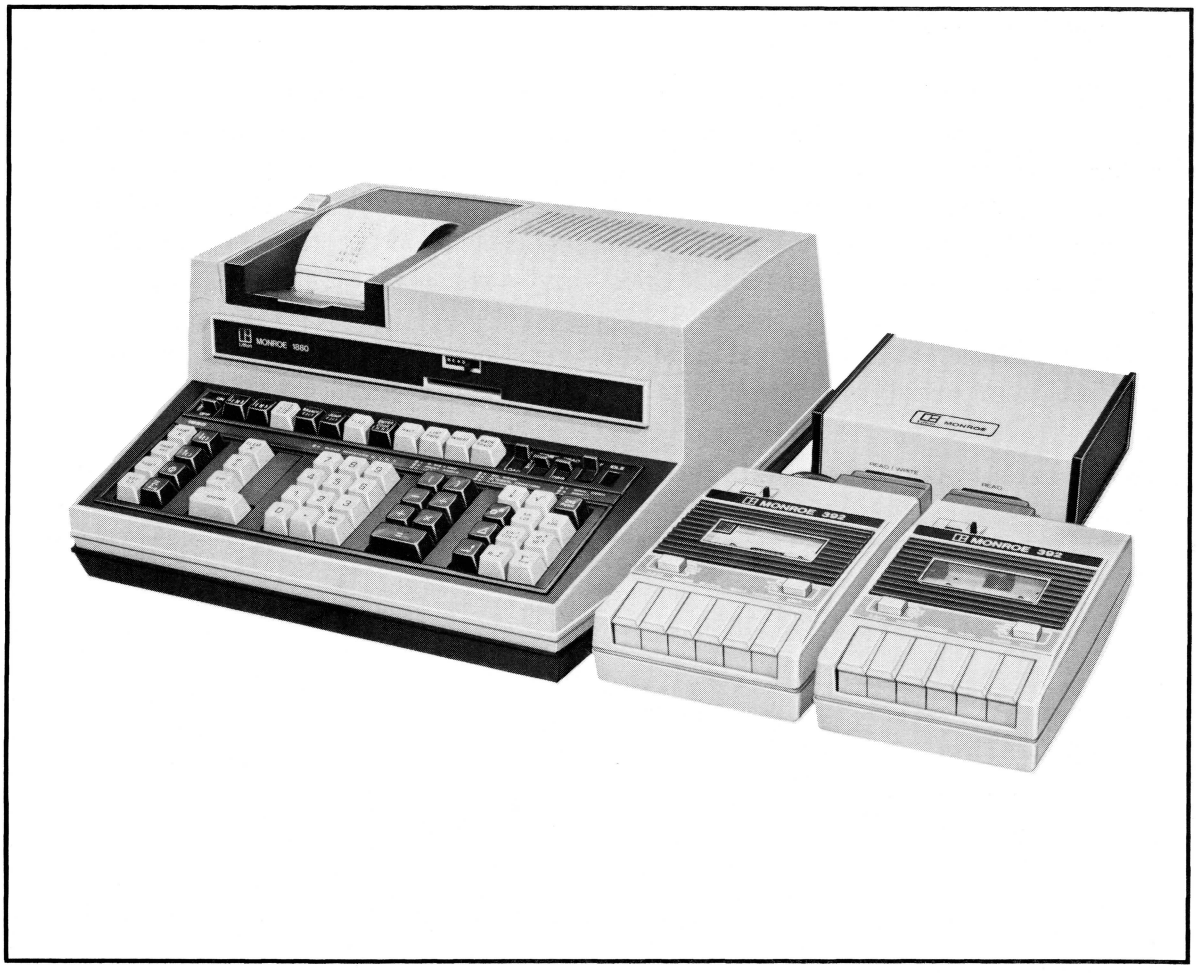


Figure 2 Monroe 1800 Series Computer with Two 392 Tape Drives

This ability to program tape drive operations greatly increases the effective size of the program memory and the data storage area.

For example, a large program may be divided into a number of segments, where each program segment performs a specific part of the computation. The program segment currently in the computer's memory can include as its final instruction the command to read the next program segment from tape into memory. Thus a very large program could be executed in segments. This is known as a program overlay technique, because the new program segment brought into the computer's memory overlays and replaces the program segment previously stored there.

Similarly, large amounts of data can be brought into the computer's storage registers from the tape. Input data could be brought into the computer from tape, computations could be done and the resulting data could be stored on tape. Then a new set of input data could be entered from tape and used for a new set of computations, and so forth.

Thus automatic program control of tape drive reading and writing operations permits you to write programs of considerably more sophistication than would be possible without the cassette drive.

TABLE 1

MODEL 392 SPECIFICATIONS

Dimensions

	392 Tape Cassette Drive	392RW Interface
Length:	8"	5-15/16"
Width:	5"	7-3/16"
Height:	3"	2-1/2"
Weight:	2 lbs. 12.5 ozs.	2 lbs. 3.5 ozs.

Operating Environment

Temperature: 50°F (10°C) – 113°F (45°C)

Relative Humidity: 20% – 80%

Tape Characteristics

Blocks per tape (C30 Monroe Tape 1823-S)*:	150 (per side)
Block Size: Steps (Bytes)/Block	256
Registers/Block	32
Read/Write Time:	5 sec/block
Tape Length:	150 feet
Tape Speed:	1-7/8 ips
Rewind Time:	43 seconds

(*) Computer grade Phillips type certified cassettes can also be used with the 392/1800 system.

392 TAPE CONTROLS

The controls used to operate the 392 Tape Cassette Drive are shown on the cover of this manual.

All tape controls are on the cassette drive; however, reading or writing on a tape also requires keyboard operations on the 1800 computer.

Control	Function
EJECT	Pressing this key lightly, opens the cassette drive door to allow the insertion or removal of the cassette. Pressing more heavily causes the tape cassette to be ejected.
RECORD	Allows data or programs to be recorded onto the tape from the data registers or program memory of the 1800. RECORD does not operate when the Write Protect tab is removed from the tape cassette (see Appendix B).
REWIND	This key causes the tape to move backwards.
READY	This key places the recorder head against the tape. READY must be pressed and latched to write onto tape or read from the tape. When writing onto tape, both READY and RECORD must be latched. When reading from the tape, only READY need be latched.
FORWARD	This key causes the tape to go forward at high speed. The tape motor does not automatically shut off when the tape is fully wound. This does not damage the tape cassette or the drive.
STOP	This key stops whatever tape motion is occurring and unlatches any other keys.
WRITE ON TAPE	WRITE ON TAPE is not used with 1800 computers.
READ FROM TAPE	READ FROM TAPE is not used with 1800 computers.

Tape Movement Counter

A digital counter that records tape movement is located in the upper left-hand corner of the face of the 392 Tape Cassette Drive. This counter is extremely useful when you wish to move to a distant point on the tape since you may use the FORWARD key with the digital counter to move rapidly to the required part of the tape and then perform the remainder of the search at the normal Read/Write speed.

Connections

The 392 Tape Drive has a permanent signal cable with a connector at the end. To connect the Tape Drive with the 1800 computer, plug the connector into the appropriate port (READ or READ/WRITE) on the interface unit. The interface unit is then plugged into a 37 pin I/O connector on the back of the 1800 computer.

Power to run the Tape Drive is supplied by the 1800 computer which uses a standard power cord. Do not turn power on until all connections have been made. Do not disconnect any cords until power is turned off.

Figure 3 shows a typical cable connection arrangement.

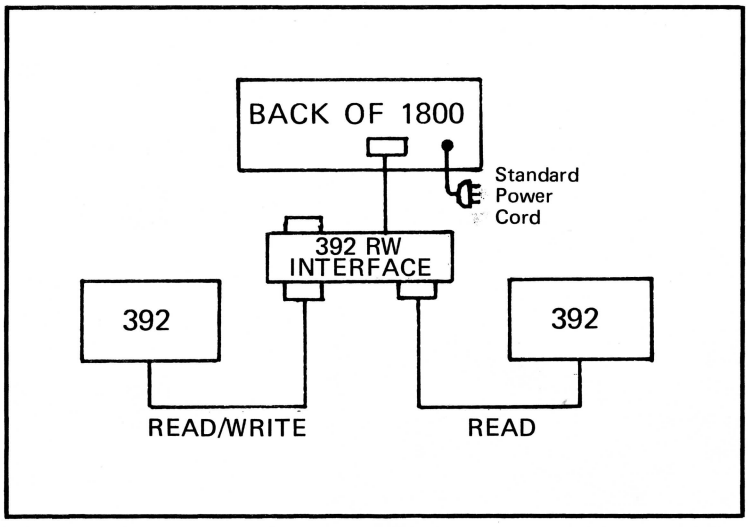
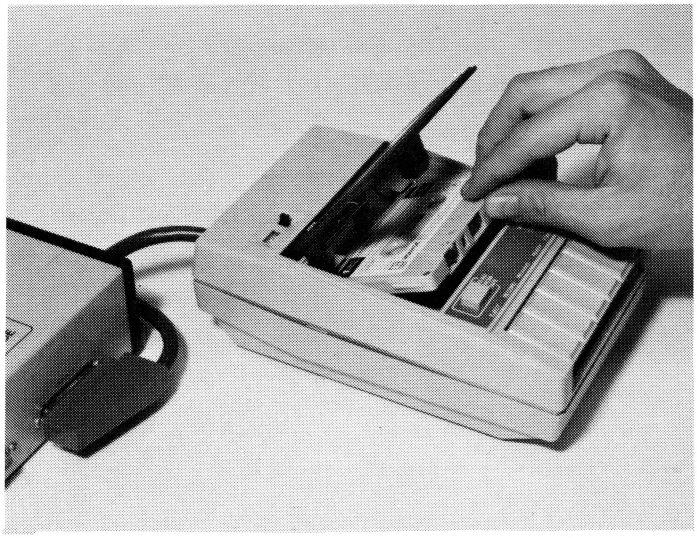


Figure 3 1800 Computer Connected to Two Cassette Drives for READ and READ/WRITE Capability

Loading a Prepared Program

To load a program into an 1800 Series calculator from a cassette tape prepared by Monroe use the following procedure:



- Connect the 392 Tape Drive to the READ port of the 392 RW Interface and turn the calculator power on.
- Press the EJECT key on the 392 Tape Drive to open the door.
- Insert the cassette with side A facing up, press down firmly so that it seats properly, and close the door.
- Press the REWIND key to rewind the tape cassette.
- Press and latch the READY key.

At the 1800 calculator:

- Press JUMP ( ) ( ) 0 0
- Load sides A and B of the magnetic card containing the 392 Accessing Routine.*
- Press JUMP ( ) ( ) IND SYMB . RESUME **
- When the idle light flashes press the number of the desired block to be read into the calculator followed by the special function key (Φ or □) and 5.
- The desired program is in the calculator; now follow the Operating Instructions for this program.

*The 392 Accessing Routine checks the calculator to see if it contains a 392 Driver ROM. If it does not, the RAM version of the 392 Driver is read from the cassette tape into user memory. The Manual Operations Routine in RAM or ROM is then accessed automatically. All cassette tapes prepared by Monroe will contain this program on the first three blocks of the tape. To learn how cassette tapes are prepared refer to Appendix G.

**On the Model 1810 press the User-Definable key next to the ON/OFF switch.

Tape Blocks and Preconditioning Tape

All tape cassettes must be preconditioned prior to use on the 392. If you are using prepared program tapes exclusively and do not plan to write your own data or programs onto tape, you need not be concerned with preconditioning tapes. All prepared program tapes that are provided to you by Monroe have already been preconditioned. Thus you may omit reading the following procedures and go to the next topic.

Preconditioning divides the tape into the number of blocks specified by the operator. Each block can hold 256 program steps or 32 data registers, and is assigned a number in sequence beginning with 1 (there are at most 150 blocks per side of a Monroe C-30 tape). A block may not be assigned a number greater than 9999.

The procedure for preconditioning a tape cassette is as follows:

1. Connect and turn on the 1800 computer and the 392 Tape Cassette Drive connected to the READ/WRITE port.

2. Insert the cassette into the 392 with the side that you wish to precondition facing up (Side A or Side B).

3. Press REWIND and fully rewind the tape.

4. Latch READY and RECORD on the 392 Tape Drive.

5. Load the Preconditioning Routine shown in Figure 4. This routine should be stored on magnetic cards for future tape preconditioning.

6. Touch JUMP, SYMBOL, 0, RESUME. Enter (via the 1800 keyboard) the number of blocks to be written on the tape (maximum of 150 per side on a Monroe C-30 tape). Then press RESUME again. After the tape is pre-blocked, the number of blank (256 byte) blocks written on the tape will be printed out on the 1800. This number should equal the number entered.

7. Rewind the tape so that recording can begin at block 1.

STEP	CODE
0000	254
1	005
2	200
3	150
4	303
5	255
6	011
7	220
8	002
9	122
0010	265
1	340
2	326
3	242
4	002
5	
6	
7	330
8	127
9	124
0020	266
1	321
2	325
3	123
4	266
5	217
6	317
7	200
8	200
9	360
0030	315
1	266
2	300
3	200
4	210
5	143
6	004
7	266
8	300
9	315
0040	124
1	200
2	230
3	360
4	315
5	273
6	257
7	032
8	331
9	273
0050	255
1	200
2	311
3	266
4	130
5	200
6	210
7	144
8	127
9	142
0060	010
1	254
2	130
3	266
4	300
5	315
6	266
7	002
8	200
9	370
0070	360
1	315
2	266
3	231
4	336
5	321
6	336
7	321
8	200
9	311
0080	266
1	200
2	200
3	370
4	266
5	077
6	317
7	370
8	144
9	127
0090	220
1	043
2	
3	
4	
5	
6	
7	
8	
9	
0100	
1	
2	
3	371
4	266
5	077
6	317
7	200
8	156
9	001
0110	115
1	373
2	030
3	373
4	322
5	325
6	050
7	372
8	272
9	060
0120	271
1	170
2	372
3	271
4	132
5	372
6	371
7	
8	301
9	241
0130	176
1	200
2	150
3	301
4	
5	
6	020
7	360
8	021
9	061
0140	342
1	260
2	214
3	261
4	214
5	061
6	342
7	250
8	213
9	371
0150	
1	
2	353
3	353
4	353
5	256
6	236
7	371
8	350
9	352
0160	220
1	233
2	
3	
4	
5	
6	
7	066
8	000
9	266
0170	077
1	317
2	056
3	154
4	110
5	000
6	266
7	002
8	316
9	316
0180	200
1	000
2	360
3	316
4	316
5	154
6	111
7	000
8	060
9	126
0190	067
1	000
2	200
3	361
4	200
5	362
6	304
7	304
8	334
9	252
0200	346
1	360
2	365
3	322
4	022
5	266
6	300
7	315
8	200
9	362
0210	042
1	343
2	343
3	022
4	315
5	266
6	003
7	200
8	370
9	364
0220	340
1	242
2	300
3	364
4	360
5	315
6	200
7	362
8	220
9	315
0230	
1	
2	266
3	300
4	200
5	361
6	200
7	364
8	200
9	364
0240	360
1	315
2	200
3	364
4	371
5	
6	
7	
8	021
9	360
0250	061
1	346
2	251
3	373
4	371
5	

Figure 4 Tape Preconditioning Routine

Tape Organization

Once the cassette tape has been preconditioned, 256 bytes of information may be stored in each block; in addition, several bytes of information are stored automatically in each block by utility routines. The organization of the tape is shown in Figure 5.

The first two bytes constitute the block number, which is assigned by the Preconditioning Routine. The next two bytes contain the address (14 bits) from which the block was written and a link bit which indicates whether or not the next block on the tape is to be automatically loaded after the current block. The next two bytes contain the end address, that is, the address at which the block of information will stop being written. The last byte contains the checksum for the block which is used to verify the validity of the data read from the tape.

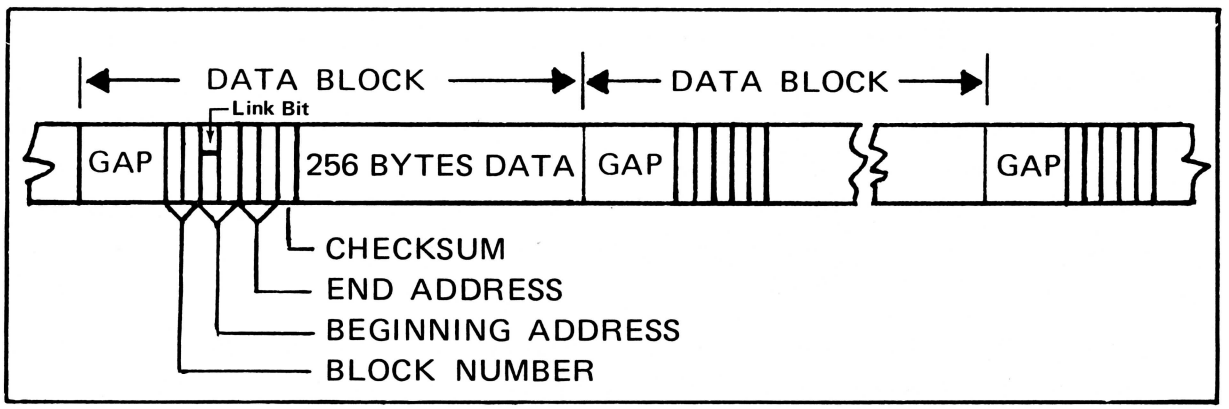


Figure 5 Tape Organization

When information is written from computer memory to a cassette tape, the information to be written into each block must constitute a contiguous 256 byte area in memory (either 256 contiguous program steps or 32 contiguous data registers). If more than 256 bytes of related information are to be written onto tape, and it is desired to be able to subsequently load all information with a single operation, two or more blocks on the tape can be linked together. For example, suppose a 768 step program is to be written onto tape, and it is desired to be able to load all 768 steps with a single load operation. Three successive blocks of 256 bytes on the tape can be used to store the program steps. The link bits can be set in the first and second blocks; during the load operation, these link bits will be taken to mean "automatically load the next block". In this way, all three blocks can be loaded in a single operation by specifying only the block number of the first block, and a read instruction.

When each block is written on the tape, the address in computer memory from which the first byte is written is recorded on the tape. As blocks of information are read from tape to

computer memory, these recorded addresses may be used to determine the location in the 1800 memory for each block of 256 bytes. Alternatively, the recorded addresses may be ignored with loading addresses specified at load time.

When two or more blocks are linked together on cassette tape, the blocks need not have been written from adjacent areas in computer memory. For example, three blocks may be linked together, with the first block containing program steps 000 through 255, the second block containing steps 503 through 758, and the third block containing registers 11 through 42. When these three blocks are to be read into the 1800, the firmware can be instructed to load the three blocks into the same areas from which they were written; the firmware does this by using the address recorded on each block of tape. In this example, the three blocks would be read into steps 000 through 255, steps 503 through 758, and registers 11 through 42. Alternatively, the firmware can be instructed to ignore the addresses recorded on the blocks, and to read all three blocks into the calculator beginning at a particular memory location which is specified when the read instruction is given. In this case, all blocks are read into a single contiguous area of computer memory even though they were written out from non-adjacent areas. In this example, 768 bytes from the three blocks would be read into contiguous memory locations beginning at the specified load addresses.

The recorded block addresses are especially useful for programs stored on cassette tape. These pre-recorded addresses, when used in conjunction with link bits, permit a program to be loaded into appropriate locations in computer memory with a single load instruction; no loading address need be specified when the program is loaded.

When reading data from the cassette, it may be useful to use the feature which permits block address to be ignored, since it may be necessary to write data onto tape from one location and subsequently read it back into another location for further processing. The link bits may still be used to chain several blocks of 256 bytes.

1800/392 Driver Routine

In order to operate the 392 Cassette Drive with an 1800 computer, a 392 Driver Routine is required. This routine has been stored on a chip and placed in the ROM (Read Only Memory) area of the 1800 computer (in columns 70, 71 and 72). However, if you have a peripheral device which requires extended use of the ROM, a RAM (Random Access Memory) software version of the Driver Routine can be loaded into user memory (see Appendix D).

Two kinds of tape manipulation capabilities are provided by the 392 Driver Routine firmware; manual operations, with which an operator can cause information to be written onto or read from the cassette tape by touching an appropriate sequence of keys on the 1800 keyboard; and programmable operations, which can be used to incorporate automatic tape manipulation as part of an applications program by including the appropriate sequences of codes in the program. Manual operations will be used primarily for writing programs on tape and subsequently loading them back into the computer, although they may be used to write and read data as well. Programmable operations will be used primarily to write data onto tape and read them back automatically, but may also be used to write and read programs or program segments (for example, when the program overlay technique is used).

4

Accessing Manual Operations

Manual operations are the tape manipulations which an operator can perform at the 1800 keyboard. In order to access manual operations the operator must key in a jump to a convenient point in memory (say step 490). At this point a symbol (say SYMB•) is loaded along with the codes for an off-page jump to the Manual Operations Decoding Routine in ROM. (If you do not have a ROM Driver Routine see Appendix D.) Once the Manual Operations Routine is accessed (by touching JUMP, SYMB, •, RESUME), the various read and write tape commands may be performed from the keyboard. The manual read and write tape commands are given in Table 2.

After the read or write command has been decoded by the Manual Operations Routine, it is executed and control is returned to the operator. To break from the Manual Operations Routine press RESET; this will restore normal keyboard operations. Once RESET is pressed, JUMP, SYMB, •, RESUME must be re-entered to return to the Manual Operations Routine. Figure 6 shows how manual operations are accessed from the keyboard.

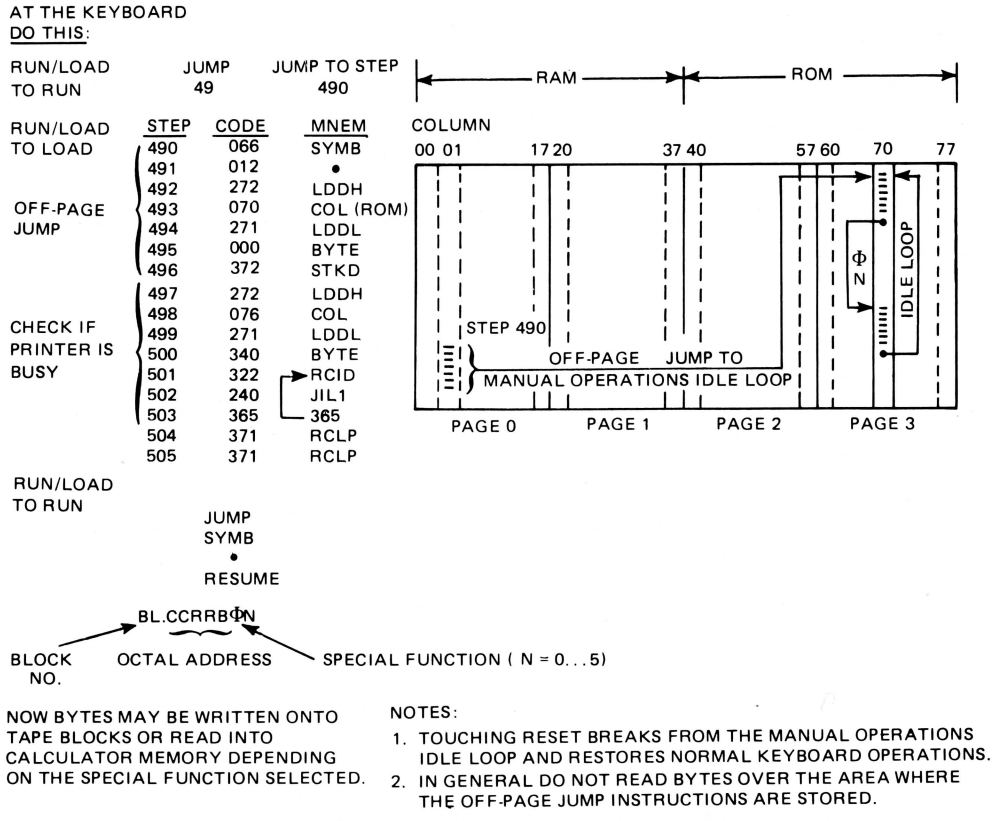


Figure 6 Accessing Manual Operations from the Keyboard

Read and Write Commands

The 392 Tape Cassette Drive records data in blocks of 256 bytes (one column length). The tape drive does not distinguish between bytes in program memory or data register memory. It simply records each block beginning with the octal address specified by the operator. Figure 7 shows the relationship between cassette tape format and 1800 memory storage.

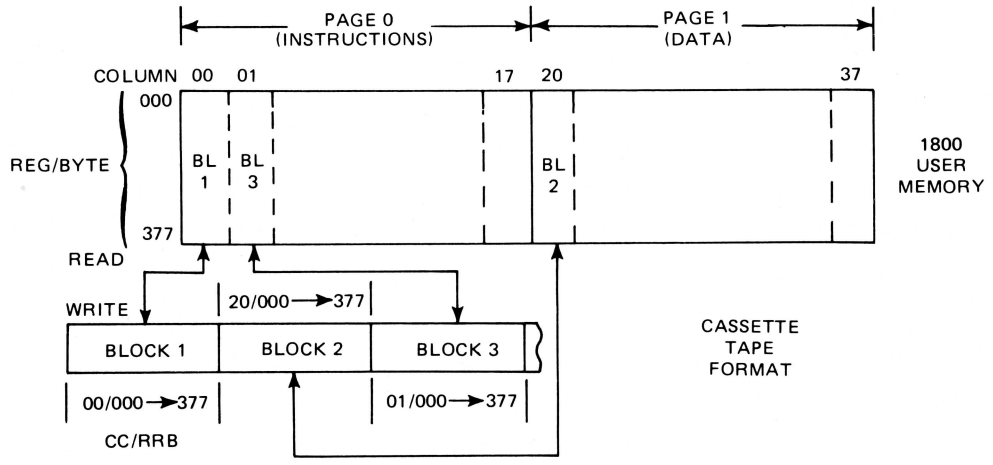


Figure 7 Relationship Between Cassette Tape Format and 1800 Memory Storage

When writing onto tape, a link bit may be set which links blocks together so that when reading from the cassette the next block will automatically be loaded into computer memory. When linked, blocks may be read into the 1800 memory storage according to the address recorded on tape or they may be loaded into contiguous areas if a loading address is specified.

The ability to write, read, and link blocks on a cassette tape provides four special functions which can be performed at the READ/WRITE port:

Φ 0 – Write 256 bytes of information onto a single block.

Φ 1 – Write 256 bytes onto a block and link next block so it will also be loaded into memory when tape is being read.

Φ 2 – Read a block (or linked blocks) into a specified address in computer memory (addresses recorded on tape are ignored).

Φ 3 – Read a block or linked blocks into the addresses recorded on tape.

The special functions which can be performed at the READ port are as follows:

Φ 4 – Read a block (or linked blocks) into a specified address in computer memory (addresses recorded on tape are ignored).

Φ 5 – Read a block or linked blocks into the addresses recorded on tape.

The keyboard sequences which must be followed to perform manual tape operations are given in Table 2. A diagram of the tape reading and writing functions is provided in Figure 8. If the register and byte (RRB) are not specified in an address the beginning of the column (CC) will be assumed.

Table 2. **MANUAL TAPE COMMANDS**

Port	Keyboard Sequence Block.Address	Special Function*	Description
READ/WRITE	BL.CCRRB	Φ 0	Write 256 bytes onto block BL, start at column CC register/byte RRB. Link bit is reset, this block not linked to next block.
	BL.CCRRB	Φ 1	Write 256 bytes onto block BL and set link bit so next block will follow into memory when tape is being read. Start at column CC register/byte RRB.
	BL.CCRRB	Φ 2	Read block BL from tape into memory starting at column CC, register/byte RRB. If block BL was written with a Φ1 command, block BL + 1 will be read into column CC + 1. Blocks continue to be read in this fashion until a block written with a Φ0 command is encountered.
	BL	Φ 3	Read block BL from tape into the address specified by the address bytes on the tape. Linked blocks will be loaded according to their respective addresses.
READ	BL.CCRRB	Φ 4	Same as Φ2 except computer reads from tape drive connected to READ port.
	BL	Φ 5	Same as Φ3 except computer reads from tape drive connected to READ port.

*On Models 1810 and 1830 use □ instead of Φ.

When either the read or write operations are complete, the number of the next block will be printed in black on the paper tape. If the cassette tape head is already past the block requested, the block number of the next block will be printed in red. Also, the computer does a checksum of the data read in, it will detect an error if the data has been altered such that the sum of the data bits read in is no longer the same as when it was written on tape. A complete list of error codes is provided in Appendix A.

The remainder of this chapter provides examples of reading and writing on a preconditioned cassette tape. For these examples, the preconditioned tape should be placed in the drive connected to the READ/WRITE port.

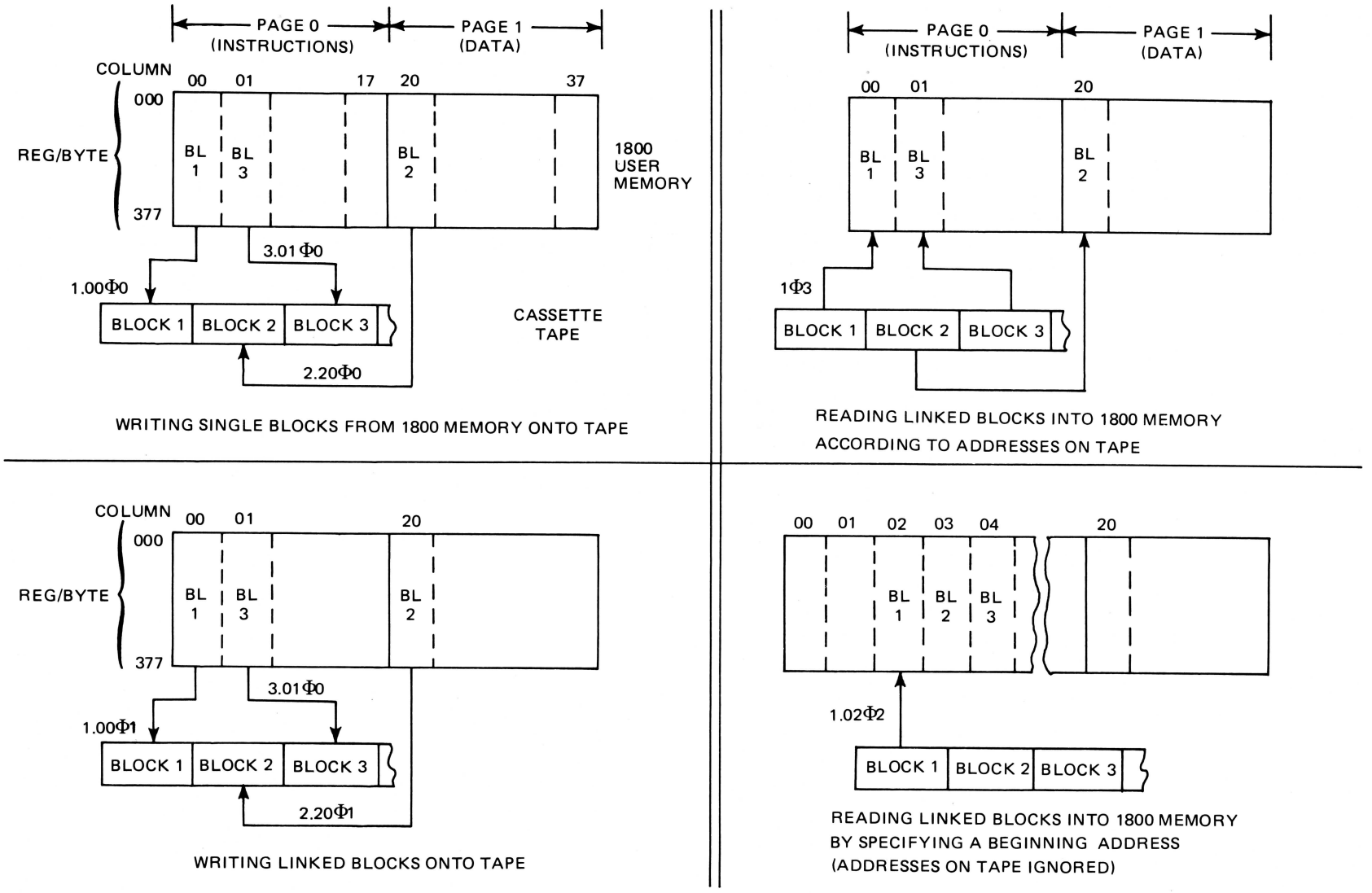


Figure 8 Tape Reading and Writing Functions

Example: WRITING A PROGRAM ONTO TAPE

Let's write a sample program on a block of tape. First load the off-page jump instructions and press JUMP, SYMB, •, RESUME. This accesses the Manual Operations Routine (see Figure 6). Suppose there is a program in the computer's memory that computes the square root of the sum of an entered number, X, plus 2. The instructions for this program are as follows:

MEMORY STEP	INSTRUCTION CODE	KEY	COMMENTS
0000	056		Stop to enter a number X
0001	021	+	Add 2 to the number X
0002	002	2	
0003	020	=	Calculate sum
0004	055	√	Take square root
0005	126	Ju	
0006	000	0	Jump to step 000
0007	000	0	

To write the program on tape in block number 3:

Do This	Comments
Set RUN/LOAD switch to RUN	
Rewind the tape cassette	
Press and latch READY and RECORD	
JUMP, SYMB, •, RESUME	Access the Manual Operations Routine.
Press 3 . 0 0 Φ 0	Write column 00 onto block 3.
	Tape stops after having written the program onto block 3.
	(All 256 steps of column 00 are written onto block 3.)

Example: READING A PROGRAM FROM TAPE

In this example we will read the program previously stored on block 3 of the tape into program memory. First, turn the 1800 off using the ON/OFF switch. This erases the computer's program memory. Turn the computer on again. Program memory is now blank. (Turning the computer off is not necessary and is done in this example for dramatic purposes.)

To read the program from block 3 on the tape into program memory:

Do This	Comments
Rewind the tape cassette	
Press and latch READY	
Press JUMP, 4, 9 (step 490)	
Set RUN/LOAD switch to LOAD	First load the off-page jump instruction at step 490
Enter codes: 066 SYMB 012 • 272 LDDH 070 CCC 271 LDDL 000 RRB 372 STKD 371 RCLP 371 RCLP	
Set RUN/LOAD to RUN	
JUMP, SYMB, •, RESUME	Access Manual Operations Routine.
Press 3.00 Φ 2	Read block number 3 into memory (column 00). A search is made for tape block 03. The tape cassette stops after block 03 has been located. The desired program is now in memory.

To run the program that calculates $\sqrt{x + 2}$, which has been read into program memory.

Do This	Comments
Reset	Break from the Manual Operations Routine.
JUMP 0, 0	Jump to step 000 in memory.
RESUME	Resume execution of program. Program is stopped for entry of X.
Enter X = 5 RESUME	Calculate value of $\sqrt{5 + 2} = \sqrt{7} = 2.6457$
Enter X = 14 RESUME	Calculate value of $\sqrt{14 + 2} = \sqrt{16} = 4.0000$

Example: WRITING FROM DATA REGISTERS ONTO TAPE

Suppose we wish to write the contents of data storage registers 00–03 onto tape block 1. Assume that the data registers contain the following numbers:

Register 00	5.0000
Register 01	10.0000
Register 02	20.0000
Register 03	35.0000

Note that column 20 (octal) contains registers 00 through 31 (decimal).

Rewind the tape and proceed as follows:

Do This	Comments
Press and latch READY and RECORD	
JUMP, SYMB, •, RESUME	Access the Manual Operations Routine.
Press 1 . 2 0 Φ 0	Write column 20 (octal) onto tape block 1.
	Tape stops after writing the data registers (00 through 31) from column 20 onto block 1.

Example: READING FROM A TAPE BLOCK INTO DATA REGISTERS

To read the information stored in tape block 01 in the previous example into data registers 00–03, proceed as follows:

Do This	Comments
Rewind the tape	
Press and latch READY	
JUMP, SYMB, •, RESUME	Access the Manual Operations Routine.
Press 1 . 2 0 Φ 2	Read block 1 into data memory (column 20).
Press RESET	Break from the Manual Operations Routine.

Do This	Read This	Comments
00	5.0000	The information that was previously written onto tape block 1 from data registers 00–03 has now been read back into data registers 00–03 of the 1800.
01	10.0000	
02	20.0000	
03	35.0000	Recall the numbers stored in registers 00–03.

This chapter is for programmers who want tape manipulations to be performed automatically under program control. Program control is accomplished by including steps in an application program which perform an off-page branch to the entry point of the special function routines. The application program branches to a point in program memory which contains the instructions for an off-page branch to the ROM routines.

To perform automatic tape manipulations, branch to a convenient step in memory (say step 400), use Appendix C to determine its octal address (01/220), and load the codes for the off-page branch (see Figure 9). In the application program enter the following codes:

	BL • C C R R B	The block number and the octal machine address where the block is to be read into or written from.
Enter code Enter code	201 220	Branch to the octal address of the step containing the off-page branch (col. 01 reg./byte 220 = step 400).
	002	Special Function 2 (read tape block BL into column CC reg./byte RRB).

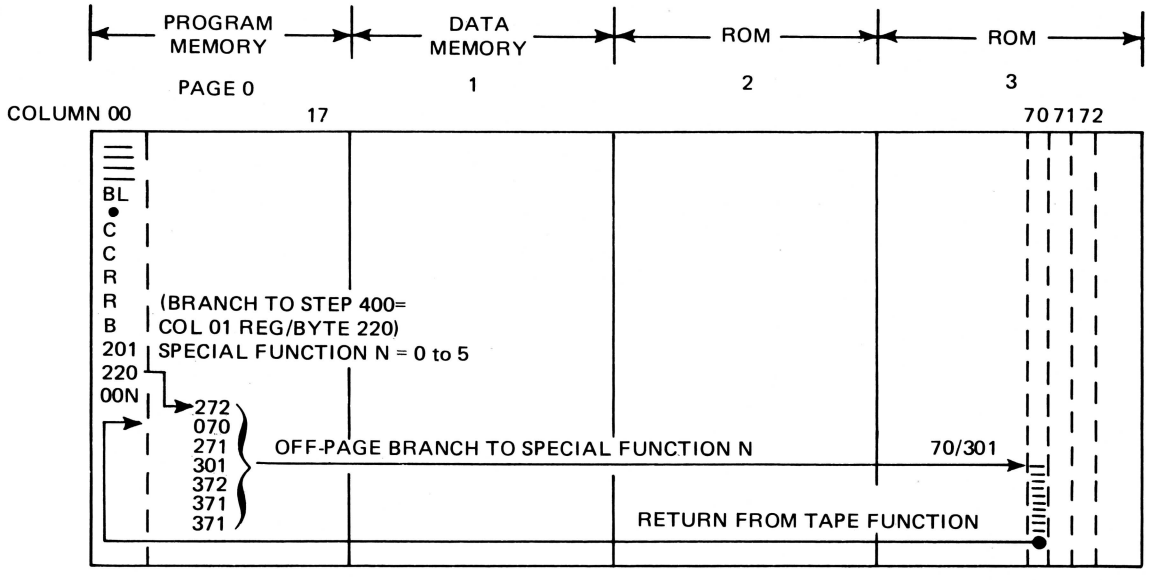


Figure 9 Automatic Tape Manipulation Under Program Control

After performing the designated special function, the ROM routines return control to the application program just past the original branch point.

Techniques for Using Tape Under Program Control

With programmed tape control, a program too large to fit into program memory can be divided into two or more sections or overlays. The 1800 can use one section and then, at the appropriate time, automatically read the next section into program memory.

A variation of the overlay technique uses the logical decision capability of the 1800 to choose which particular program segment is to be used next.

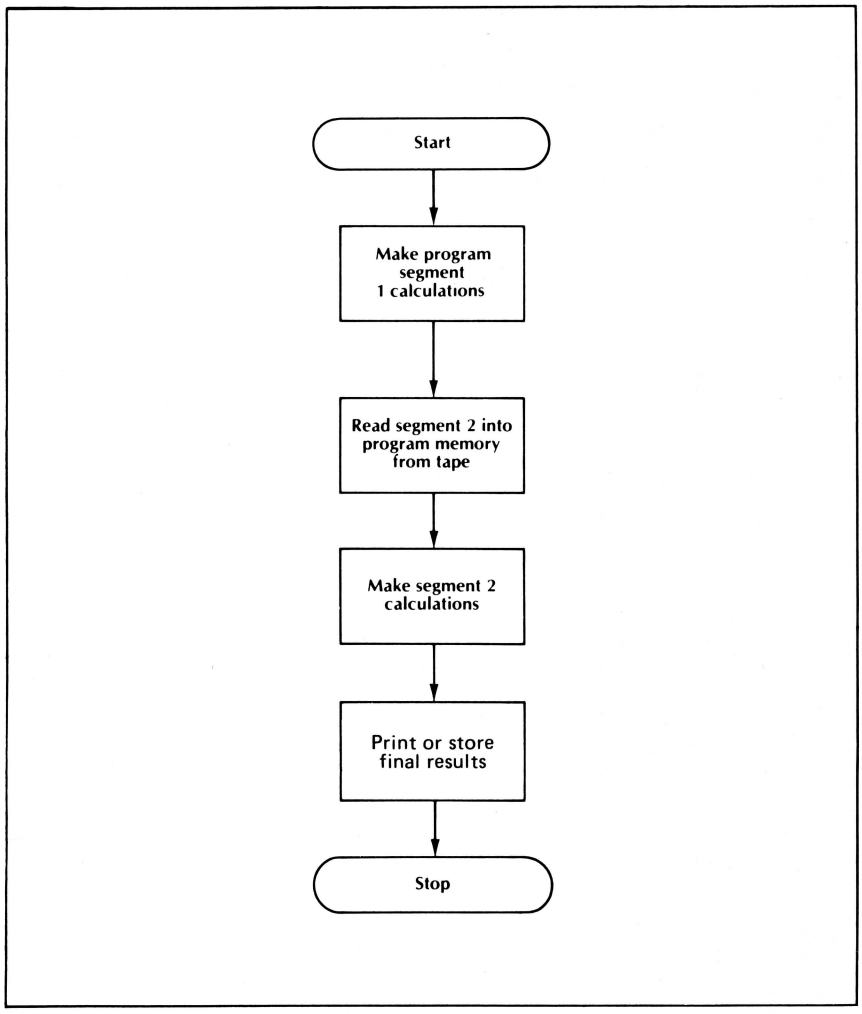

Start
Make program segment 1 calculations
Read segment 2 into program memory from tape
Make segment 2 calculations
Print or store final results
Stop

Figure 10 Flowchart for a One Block Program Overlay

Registers are not altered as new sections of a program are read from the tape. Registers can be used to store the results needed to execute the next section of the program.

The flowchart in Figure 10 shows the general form of the program that uses a one-block overlay.

The flowchart in Figure 11 shows the general form of a program that selects one of two possible overlay blocks, depending on the result of calculations performed.

Figure 12 shows the general flowchart of a program that requires more data storage registers than is available. Part A shows a repeated writing of the contents of data registers onto different blocks of tape. Part B of the figure shows a successive reading of different sets of data values of the computer's data registers from different tape blocks as needed.

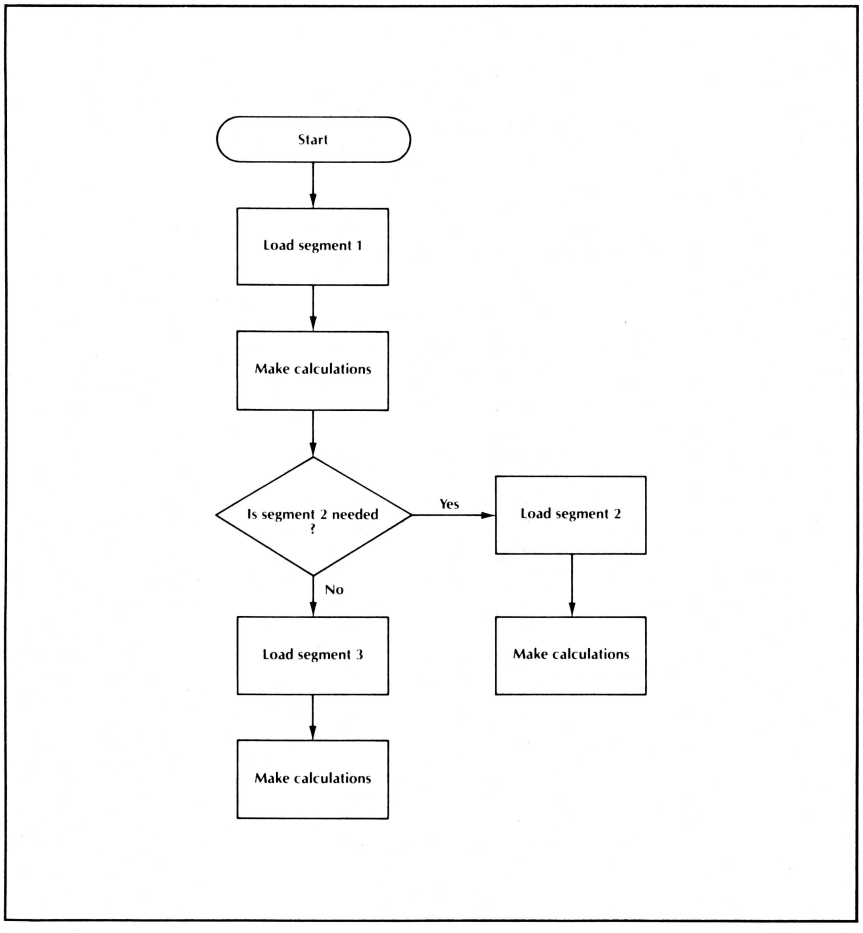


Figure 11 Flowchart for a Program that Chooses One of Two Possible Overlays

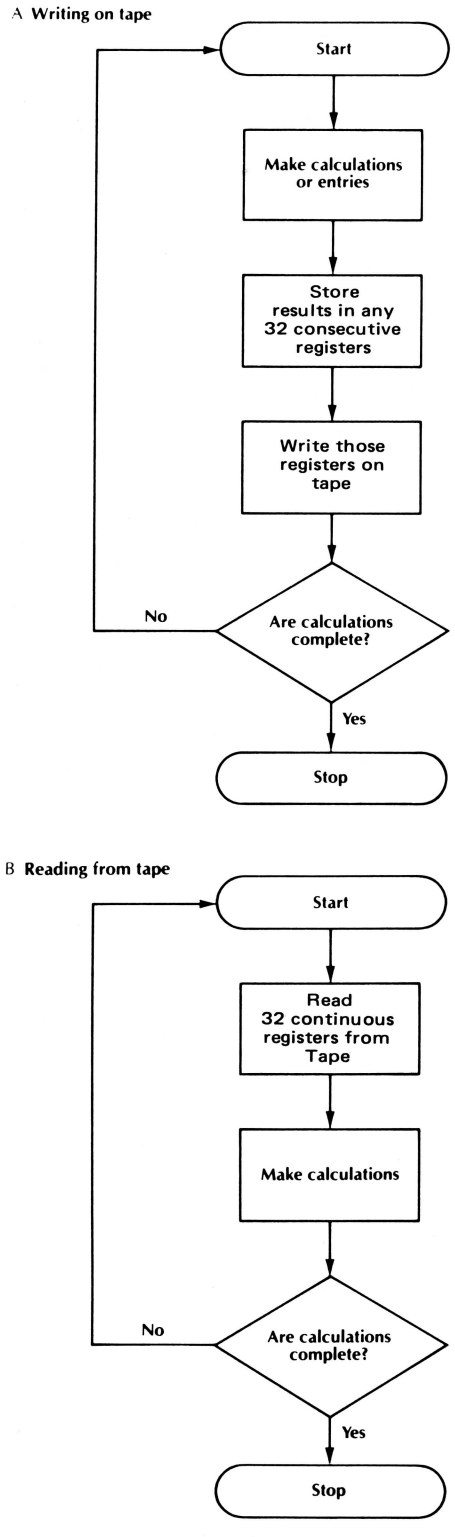


Figure 12 Flowchart for a Program that Requires More Than Register Increments Available

Example: AUTOMATIC PROGRAM CONTROL USING TAPE BLOCK OVERLAYS

This example demonstrates techniques for writing a program that uses overlays. The program shown in Figure 13 consists of 3 segments: the main program segment and two overlay segments. Each segment is programmed and written on a block of a preconditioned tape cassette. The preconditioned tape is placed in the drive connected to the READ/WRITE port.

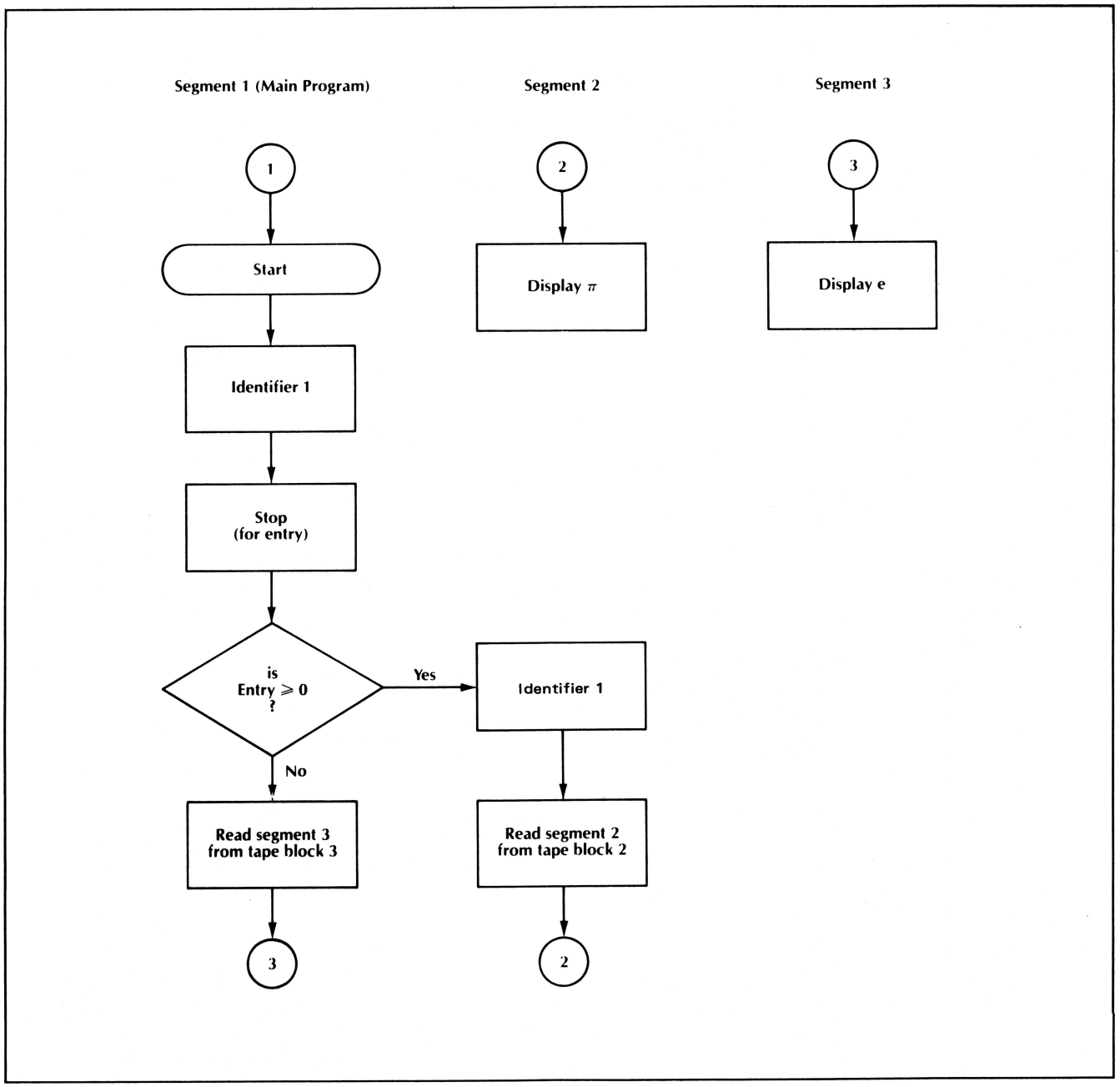


Figure 13 Flowchart for Writing a Program Using Tape Block Overlays

The main program (segment 1) tests a keyboard entry. If the entry is greater than or equal to zero, segment 2 is read from the tape and executed. If the entry is less than zero, segment 3 is read from the tape and executed.

The execution of segment 2 (when the entry ≥ 0) causes the number π (=3.1415) to be printed.

The execution of segment 3 (when the entry < 0) causes the number e (=2.7182) to be printed.

Each segment is programmed and written on a block of tape as follows:

- Segment 1 is written on block 1.
- Segment 2 is written on block 2.
- Segment 3 is written on block 3.

To load segment 1 into program memory:

Do This			Comments
JUMP, 0, 0			Jump to step 000
RUN/LOAD to LOAD			Segment 1 starts at program memory location 000.
0000	001	1	Identifier 1
0001	EC 177	ID	
0002	056	HALT	Stop for entry
0003	060	PRINT X	Print entry
0004	126	Ju	Jump to symbol $\sqrt{\ }$ if entry is < 0
0005	022	-	
0006	067	SYMB	
0007	055	$\sqrt{\ }$	
0008	002	2	OTHERWISE IF ENTRY ≥ 0
0009	012	.	
0010	000	0	Place block 2 of tape and column 00/register 34 byte 5 in entry register
0011	000	0	
0012	003	3	
0013	004	4	
0014	005	5	
0015	EC 200	BR: Col 00	Branch to column 00 register 31 byte 0 (step 200, see Appendix C) where off-page branch to special function routines is stored. Perform special function 2 (read block 2 into 00/345 of memory).
0016	EC 310	BYTE: 310	
0017	002	2	

Do This				Comments
RUN/LOAD to RUN BRANCH 00 20 (step 200) RUN/LOAD to LOAD				Branch to step 200 (octal address 00/310).
0200		272	LDDH	Load instructions for off-page branch to ROM functions.
0201		070	COL	
0202		271	LDDL	
0203		301	BYTE	
0204		372	STKD	
0205		371	RCL P	
0206		371	RCL P	
RUN/LOAD to RUN JUMP 02 (step 20) RUN/LOAD to LOAD Press BACKSPACE twice				
0018		126	JU	Jump to symbol 2 which marks beginning of program segment 2.
0019		067	SYMB	
0020		002	2	
0021		066	SYMB	Defines subroutine labelled by √ symbol.
0022		055	√	
0023		003	3	Place block 3 of tape and column 00/register 34 byte 5 in entry register
0024		012	•	
0025		000	0	
0026		000	0	
0027		003	3	
0028		004	4	
0029		005	5	
0030	EC	200	BR: Col 00	Branch to column 00. Register 31 byte 0 (step 200) where off-page branch to special function routines is stored. Perform special function 2 (read block 3 into 00/345 of memory).
0031	EC	310	BYTE: 310	
0032		002	2	
0033		126	JU	Jump to symbol 3 which marks beginning of program segment 3.
0034		067	SYMB	
0035		003	3	
RUN/LOAD to RUN				The number in entry register prior to LOAD is returned.

To write segment 1 onto block 1:

Do This			Comments
Rewind the tape			
Press and latch RECORD and READY			
Press JUMP, 4, 9 (step 490)			
Set RUN/LOAD switch to LOAD			
0490	066	SYMB	Load off-page branch to Manual Operations Routine at Step 490.
0491	012	•	
0492	272	LDDH	
0493	070		
0494	271	LDDL	
0495	000	0	
0496	372	STKD	
0497	371	RCL P	
0498	371	RCL P	
Set RUN/LOAD switch to RUN			
Press JUMP, SYMB, •, RESUME			Access the Manual Operations Routine.
1.00 Φ0			Write contents of column 00 onto tape block 1.
			The system searches for Block 1 and writes the capacity of column 00 (256 bytes) onto tape.
	2 • 00		Next block number 2.00 prints.
RESET	0 • 00	Λ	Break from the Manual Operations Routine.

Note: Whenever a block is loaded into program memory the symbol table is updated (the computer checks to see if symbolic addresses have been defined).

To load segment 2 into program memory:

Do This			Comments
JUMP, 0, 0			Jump to step 000
RUN/LOAD to LOAD			Start loading at step 000
0000	066	SYMB	Define symbol 2 as the beginning of program segment 2
0001	002	2	
0002	117	SET D.P.	Set decimal place to 4
0003	004	4	
0004	015	π	Recall value of π
0005	065	ADV	Advance paper tape and print the value of π to 4 places
0006	060	PRINT X	
0007	056	HALT	
RUN/LOAD to RUN			The number in the entry register prior to LOAD is retained. (LOAD mode does not change E register.)

To write segment 2 onto block 2:

Do This			Comments
Press and latch RECORD and READY			
JUMP, SYMB, •, RESUME			Access the Manual Operations Routine.
2.00 Φ 0			Write contents of column 00 onto tape.
			The system searches for Block 2 and writes the capacity of column 00 (256 steps) onto tape.
	3 • 0 0		Next block number 3.00 prints.
RESET	0 • 0 0	Λ	Break from the Manual Operations Routine.

To load segment 3 into program memory:

Do This			Comments
JUMP, 0, 0			Jump to step 000
RUN/LOAD to LOAD			Start loading at step 000
0000	066	SYMB	Define symbol 3 as the beginning of program segment 3
0001	003	3	
0002	117	SET D.P.	Set decimal place to 4
0003	004	4	
0004	015	e	Recall value of e
0005	052	F2	
0006	065	ADV	Advance paper tape and print the value of e to 4 places
0007	060	PRINT X	
0008	056	HALT	
RUN/LOAD to RUN			The number in the entry register prior to LOAD is retained.

To write segment 3 onto block 3:

Do This			Comments
Press and latch RECORD and READY			
JUMP, SYMB, •, RESUME			Access the Manual Operations Routine.
3.00 Φ 0			Write contents of column 00 onto block 3.
			The system searches for block 3 and writes the capacity of column 00 (256 steps) onto tape.
	4 • 0 0		Next block number 4.00 prints.
RESET	0 • 0 0	Λ	Break from the Manual Operations Routine.

To run the sample program with entries of 5 and -4 from the keyboard:

Do This			Comments
Rewind the tape			
Press and latch READY			
JUMP, SYMB, •, RESUME			Access the Manual Operations Routine.
1.00 Φ 3			Read Block 1 from tape into program memory column 00.
	2 • 0 0		Next block number 2.00 prints.
RESET	0 • 0 0	Λ	Break from Manual Operations Routine.
JUMP, 0, 0, RESUME			Begin execution at step 000.
1 •			Identifier 1 prints.
	5 • 0 0 0 0		Enter 5 as the number to be tested.
RESUME			Continue execution
	3 • 1 4 1 5		Since the number entered is greater than zero, program jumps to SYMB 2. Block 2 is automatically read into the program memory causing the value of π to be printed.
Rewind the tape			
Press and latch READY			
JUMP, 0, 0, RESUME			Begin execution at step 000.
1 •			Identifier 1 prints.
	-4 • 0 0 0 0		Enter -4 as the number to be tested.
RESUME			Continue execution
	2 • 7 1 8 2	F2	Since the number entered is less than zero, program jumps to SYMB $\sqrt{}$. Tape block 3 is automatically read into program memory causing the value of e to be printed.

Appendix A

392 TAPE CASSETTE DRIVE ERROR CONDITIONS

Tape Printout	Error
E 1 - 1.00	On READ commands, READY was not latched or the 392 was not connected. On WRITE commands, READY or RECORD or both were not latched or the 392 was not connected.
E 2 - 1.00	When the next block was requested, the end of file was encountered.
E 3	On preconditioning the tape, one of the following errors occurred: • Number entered was greater than 9999 • Number entered was negative • No number was entered
E 4 - Next block no.	An attempted read of a block that has no data written on it.
E 5 - Next block no.	Checksum error. The information read in has an error or errors. Either the tape contains a flaw or the stored data has been altered.
E 6 - Next block no.	Tape head is already past the block requested.

NOTE: The errors generated in the copy routines and preconditioning routines are hard errors. This means that the programs will not continue until some physical action by the user occurs. By contrast, the Read/Write routines generate soft errors which can be examined by programs and action taken by the software accordingly.

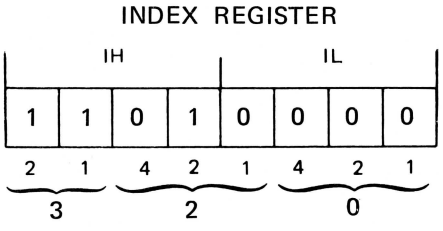
Error Detection Under Program Control

After returning from a programmed read or write operation on the 392, the entry register contains the next available block number (a positive number). If an error occurred, the number in the entry register will be the negative of the next available block number except for errors 1 and 2 which cause a negative one to appear.

The number of the type of error is stored in the IL portion of the index register. Therefore, we can write a program which checks to see if the entry register is negative after a programmed tape operation and if it is, prints the type of error as an identifier. The following program may be used to test for errors under program control.

Branch to off-page branch routine and perform special function N	2CC RRB 00N	or	2CC RRB 00N
JU if	126	JMZP	255
+ to	021		
SYMB	067		
1	001		
Otherwise			
PRINT	060		060
LDIH	265		265
Digit 13	320		320
CLRE	330		330
XFIE	325		325
PRINT ID	177		177
HALT	056		056
SYMB	066		
1	001		

Octal Address



Note that the application programmer is to determine whether the program is to halt when an error is detected on a tape operation or if the program is to resume, printing the type of error and the block number where an error occurred. This may be convenient when many blocks of data are to be interpreted and an operator can not be present at the machine.

Appendix B

NOTES ON THE TAPE CASSETTE DRIVE

Maintenance

The following points should be noted with respect to maintenance of tape cassettes and the 392 Tape Cassette Drive:

1. If tape cassettes from suppliers other than Monroe are used with the 392 Tape Cassette Drive, the tape must be computer grade tape that is free of flaws.

2. It is important not to subject the Tape Cassette Drive to external shocks while it is reading or writing tape. Sudden movements or shocks may result in a failure to read or write some portion of the tape correctly, which can cause an error condition.

3. The Tape Cassette Drive's recording head must be kept clean to assure that information is correctly written onto and read from tape. After approximately 200 tape reading or writing operations, or if there seems to be difficulty in reading or writing correctly, clean the recording head using the following procedure:

   (a) Press the EJECT key to open the door of the Tape Cassette Drive and remove the tape cassette.

   (b) Press the READY switch to move the recording head forward.

   (c) Rub the recording head gently using a cotton swab moistened with denatured alcohol. Remove any other dust in the vicinity.

   (d) Dry the recording head with a clean dry cotton swab.

   (e) Press the STOP key to retract the recording head.

   (f) Close the door to prevent excess dust from accumulating.

4. When not in use, do not leave the Cassette Drive in the READY mode since this can cause tape deformation by continuous contact pressure being exerted on the tape. If an attempt to insert a cassette is made with the READY key depressed misalignment of, and damage to the head may occur. Either remove the cassette from the transport or verify that the tape is positioned on the clear-leader when switching the calculator ON. Be sure the READY key is up by pressing STOP before turning on the calculator.

5. When using a new cassette, assign a serial number to it and record that number on the cassette permanent label. Keep a log of cassette serial numbers and the initial date used so you can estimate wear by the cassette age. Periodically examine the log of cassette serial numbers and the permanent labels on the cassettes. If a cassette is too old to continue using or if there are more than two defective blocks that preblocking again does not remove, replace the cassette.

6. If an error occurs when trying to read or write on a cassette tape check that the proper procedure was followed and that the recording head is clean. Then try the read or write operation again.

7. Whenever a cassette error occurs on the same block repeatedly, or after approximately 200 reads, copy the cassette as soon as possible. After the tape has been copied it may be preconditioned for re-recording. Preconditioning erases the contents of the tape.

Storing Cassette Tapes

1. When through with a cassette always rewind the tape prior to removal from the tape drive. This subjects only the clear leader to dust, dirt, scratches, tears and abrasions. Under no circumstances should the tape itself be touched since fingerprints on the tape can create adhesive areas for dust and lint.

2. Since magnetic tapes are easily damaged, be sure to put each tape cassette in its plastic case when you have finished using it.

3. As with most magnetic tape products, the information recorded in the tape cassette can be altered or destroyed if it is exposed to a strong magnetic field, such as one produced by a toy magnet, or a metal detection device (like the ones used in many airports) or the rear and top panels of the calculator. If you keep your tape cassettes in a metal container, such as a card index box, they will be protected from most magnetic fields. It is good practice to make duplicate tapes of important programs or data.

4. Do not write on a cassette label with an erasable pencil. Use a fiber tip or ball point pen. When starting a new job on a cassette, cross out the old information on the label — do not erase it (the dust from the erasing can get inside the cassette).

5. When the label is full, remove the old label before attaching a new one. If new labels are pasted over old ones, the label build up affects machine performance. Do not cover any of the holes.

6. Replace the cassette if it is physically damaged or if the recording surface becomes contaminated. Placing a contaminated cassette in a device can contaminate the read/write head, causing operating errors. In addition, contaminants can be passed to clean cassettes.

7. Do not put rubber bands around the cassette cases because this could distort the alignment of the tape spools. Also, do not expose the cassette to excessive heat or sunlight.

Protection of Tape Against Accidental Erasure

After information has been recorded, cassettes may be protected from accidental erasure by removing the Write Protect Tabs. Of course, this prevents you from writing new information on that tape and implies that you are storing a program or data permanently rather than temporarily. Cassettes have two write protect tabs, one for each side of the cassette (see Figure 14).

Additional cassettes are available through your Monroe representative and are designated by the following part number: Monroe C-30 Tape Cassette Part Number 1823-S

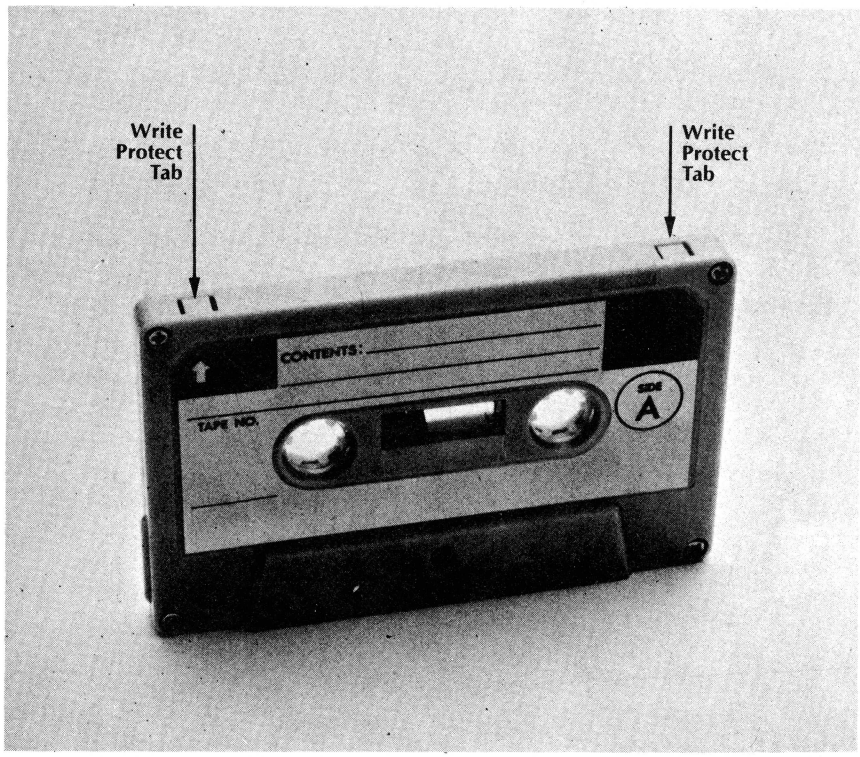


Figure 14 Monroe Tape Cassette (Part No. 1823-S) Write Protect Tabs

B

PAGE 0

REG/BYTE	COLUMN 00	01	02	03	04	05	06	07	10	11	12	13	14	15	16	17
000	0	256	512	768	1,024	1,280	1,536	1,792	2,048	2,304	2,560	2,816	3,072	3,328	3,584	3,840
010	8	264	520	776	1,032	1,288	1,544	1,800	2,056	2,312	2,568	2,824	3,080	3,336	3,592	3,848
020	16	272	528	784	1,040	1,296	1,552	1,808	2,064	2,320	2,576	2,832	3,088	3,344	3,600	3,856
030	24	280	536	792	1,048	1,304	1,560	1,816	2,072	2,328	2,584	2,840	3,096	3,352	3,608	3,864
040	32	288	544	800	1,056	1,312	1,568	1,824	2,080	2,336	2,592	2,848	3,104	3,360	3,616	3,872
050	40	296	552	808	1,064	1,320	1,576	1,832	2,088	2,344	2,600	2,856	3,112	3,368	3,624	3,880
060	48	304	560	816	1,072	1,328	1,584	1,840	2,096	2,352	2,608	2,864	3,120	3,376	3,632	3,888
070	56	312	568	824	1,080	1,336	1,592	1,848	2,104	2,360	2,616	2,872	3,128	3,384	3,640	3,896
100	64	320	576	832	1,088	1,344	1,600	1,856	2,112	2,368	2,624	2,880	3,136	3,392	3,648	3,904
110	72	328	584	840	1,096	1,352	1,608	1,864	2,120	2,376	2,632	2,888	3,144	3,400	3,656	3,912
120	80	336	592	848	1,104	1,360	1,616	1,872	2,128	2,384	2,640	2,896	3,152	3,408	3,664	3,920
130	88	344	600	856	1,112	1,368	1,624	1,880	2,136	2,392	2,648	2,904	3,160	3,416	3,672	3,928
140	96	352	608	864	1,120	1,376	1,632	1,888	2,144	2,400	2,656	2,912	3,168	3,424	3,680	3,936
150	104	360	616	872	1,128	1,384	1,640	1,896	2,152	2,408	2,664	2,920	3,176	3,432	3,688	3,944
160	112	368	624	880	1,136	1,392	1,648	1,904	2,160	2,416	2,672	2,928	3,184	3,440	3,696	3,952
170	120	376	632	888	1,144	1,400	1,656	1,912	2,168	2,424	2,680	2,936	3,192	3,448	3,704	3,960
200	128	384	640	896	1,152	1,408	1,664	1,920	2,176	2,432	2,688	2,944	3,200	3,456	3,712	3,968
210	136	392	648	904	1,160	1,416	1,672	1,928	2,184	2,440	2,696	2,952	3,208	3,464	3,720	3,976
220	144	400	656	912	1,168	1,424	1,680	1,936	2,192	2,448	2,704	2,960	3,216	3,472	3,728	3,984
230	152	408	664	920	1,176	1.432	1,688	1,944	2,200	2,456	2,712	2,968	3,224	3,480	3,736	3,992
240	160	416	672	928	1,184	1,440	1,696	1,952	2,208	2,464	2,720	2,976	3,232	3,488	3,744	4,000
250	168	424	680	936	1,192	1,448	1,704	1,960	2,216	2,472	2,728	2,984	3,240	3,496	3,752	4,008
260	176	432	688	944	1,200	1,456	1,712	1,968	2,224	2,480	2,736	2,992	3,248	3,504	3,760	4,016
270	184	440	696	952	1,208	1,464	1,720	1,976	2,232	2,488	2,744	3,000	3,256	3,512	3,768	4,024
300	192	448	704	960	1,216	1,472	1,728	1,984	2,240	2,496	2,752	3,008	3,264	3,520	3,776	4,032
310	200	456	712	968	1,224	1,480	1,736	1,992	2,248	2,504	2,760	3,016	3,272	3,528	3,784	4,040
320	208	464	720	976	1,232	1,488	1,744	2,000	2,256	2,512	2,768	3,024	3,280	3,536	3,792	4,048
330	216	472	728	984	1,240	1,496	1,752	2,008	2,264	2,520	2,776	2,032	3,288	3,544	3,800	4,056
340	224	480	736	992	1,248	1,504	1,760	2,016	2,272	2,528	2,784	3,040	3,296	3,552	3,808	4,064
350	232	488	744	1,000	1,256	1,512	1,768	2,024	2,280	2,536	2,792	3,048	3,304	3,560	3,816	4,072
360	240	496	752	1,008	1,264	1,520	1,776	2,032	2,288	2,544	2,800	3,056	3,312	3,568	3,824	4,080
370	248	504	760	1,016	1,272	1,528	1,784	2,040	2,296	2,552	2,808	3,064	3,320	3,576	3,832	4,088

Example: Find the machine address for decimal Step 278
Answer: Step 278 is 6 bytes after step 272 the address, therefore, is Column 01 Register/Byte 026

Figure 15 Machine Address Locator for Decimal Steps

BRANCH POINTS

KEY SEQUENCE	STEP
BRANCH,9,9	990
BRANCH,.,0,0	1000
BRANCH, CHG SIGN,0,0	2000
BRANCH,EXP,0,0	3000

PAGE 1

REG/BYTE	COLUMN 20	21	22	23	24	25	26	27	30	31	32	33	34	35	36	37
000	0	32	64	96	128	160	192	224	256	288	320	352	384	416	448	480
010	1	33	65	97	129	161	193	225	257	289	321	353	385	417	449	481
020	2	34	66	98	130	162	194	226	258	290	322	354	386	418	450	482
030	3	35	67	99	131	163	195	227	259	291	323	355	387	419	451	483
040	4	36	68	100	132	164	196	228	260	292	324	356	388	420	452	484
050	5	37	69	101	133	165	197	229	261	293	325	357	389	421	453	485
060	6	38	70	102	134	166	198	230	262	294	326	358	390	422	454	486
070	7	39	71	103	135	167	199	231	263	295	327	359	391	423	455	487
100	8	40	72	104	136	168	200	232	264	296	328	360	392	424	456	488
110	9	41	73	105	137	169	201	233	265	297	329	361	393	425	457	489
120	10	42	74	106	138	170	202	234	266	298	330	362	394	426	458	490
130	11	43	75	107	139	171	203	235	267	299	331	363	395	427	459	491
140	12	44	76	108	140	172	204	236	268	300	332	364	396	428	460	492
150	13	45	77	109	141	173	205	237	269	301	333	365	397	429	461	493
160	14	46	78	110	142	174	206	238	270	302	334	366	398	430	462	494
170	15	47	79	111	143	175	207	239	271	303	335	367	399	431	463	495
200	16	48	80	112	144	176	208	240	272	304	336	368	400	432	464	496
210	17	49	81	113	145	177	209	241	273	305	337	369	401	433	465	497
220	18	50	82	114	146	178	210	242	274	306	338	370	402	434	466	498
230	19	51	83	115	147	179	211	243	275	307	339	371	403	435	467	499
240	20	52	84	116	148	180	212	244	276	308	340	372	404	436	468	500
250	21	53	85	117	149	181	213	245	277	309	341	373	405	437	469	501
260	22	54	86	118	150	182	214	246	278	310	342	374	406	438	470	502
270	23	55	87	119	151	183	215	247	279	311	343	375	407	439	471	503
300	24	56	88	120	152	184	216	248	280	312	344	376	408	440	472	504
310	25	57	89	121	153	185	217	249	281	313	345	377	409	441	473	505
320	26	58	90	122	154	186	218	250	282	314	346	378	410	442	474	506
330	27	59	91	123	155	187	219	251	283	315	347	379	411	443	475	507
340	28	60	92	124	156	188	220	252	284	316	348	380	412	444	476	508
350	29	61	93	125	157	189	221	253	285	317	349	381	413	445	477	509
360	30	62	94	126	158	190	222	254	286	318	350	382	414	446	478	510
370	31	63	95	127	159	191	223	255	287	319	351	383	415	447	479	511

Example: Find the machine address of decimal register 127.
Answer: Column 23 Register/Byte 370

Figure 16 Machine Address Locator for Decimal Registers

Appendix D

RAM VERSION OF 392 DRIVER ROUTINE

If you have a peripheral device which requires extended use of the ROM, a RAM version of the 392 Driver Routine may be loaded into user memory. The RAM routine is loaded into the main data register memory at the beginning of column 21 (which is equivalent to register 32). The RAM routine may be loaded by using the magnetic card containing the 392 Accessing Routine and a Monroe prepared cassette tape. The procedure for loading a prepared program is given in Chapter 3.

No cassette tape operations can be performed unless the 392 Driver Routine is stored in the computer. If you do not have the ROM feature which occupies columns 70 to 72, or a prepared cassette tape, the RAM Driver Routine may be loaded into the computer data registers via the keyboard and recorded on magnetic cards. The routine requires three blocks (768 steps), therefore, 96 registers are used. Each side of a magnetic card holds 256 program steps (32 registers), therefore, three card sides are required to store the routine.

The following procedure is to be used for loading the 392 RAM Driver Routine (shown in Figure 17) into the computer data registers:

1. Set the RUN/STEP/LOAD switch to RUN.
2. Press JUMP, 0, 0.
3. Set the RUN/STEP/LOAD switch to LOAD.
4. Enter all steps shown in Figure 17.
5. Set the RUN/STEP/LOAD switch to RUN.
6. Press JUMP, 0, 0.
7. Set the READ/WRITE switch to WRITE.
8. Record the entire program by feeding in the magnetic cards (card 1 sides A & B, card 2 side A only).
9. Set the READ/WRITE switch to READ.
10. Press ↓( )( ), 3, 2.
11. Load the cards into the reader in the same sequencee as recorded.

D

The fact that data memory not ROM, contains the RAM Driver Routine alters the off-page branch instructions which access manual or programmable operations. The address (DC) register must be loaded with the appropriate column number (LDDH, 021) for the off-page branch to the RAM routine as follows:

Manual Operation

Load the following codes at a convenient branch point

MNEMONIC	CODE
SYMB	066
•	012
LDDH	272
CCC	021
LDDL	271
RRB	000
STKD	372
RCLP	371
RCLP	371

Now set the RUN/LOAD switch to RUN and touch JUMP, SYMB, •, RESUME.

Programmable Operation

MNEMONIC	CODE
LDDH	272
CCC	021
LDDL	271
RRB	301
STKD	372
RCLP	371
RCLP	371

The normal manual and programmable operations as described in Chapters 4 and 5 may now be executed.

COLUMN 21 CARD 1 SIDE A

Step	Code
0000	360
1	314
2	330
3	201
4	203
5	202
6	375
7	201
8	053
9	261
0010	021
1	267
2	013
3	201
4	076
5	221
6	007
7	266
8	116
9	251
0020	002
1	201
2	053
3	261
4	002
5	265
6	237
7	020
8	265
9	277
0030	242
1	047
2	241
3	046
4	240
5	122
6	221
7	104
8	040
9	240
0040	161
1	221
2	135
3	306
4	262
5	020
6	316
7	266
8	100
9	202
0050	366
1	266
2	077
3	317
4	302
5	240
6	073
7	221
8	053
9	304
0060	021
1	371
2	272
3	043
4	271
5	040
6	372
7	371
8	202
9	124
0070	201
1	226
2	273
3	231
4	322
5	267
6	077
7	321
8	202
9	153
0080	221
1	307
2	202
3	124
4	201
5	226
6	273
7	231
8	322
9	263
0090	200
1	221
2	115
3	202
4	133
5	201
6	226
7	266
8	101
9	022
0100	202
1	222
2	273
3	241
4	322
5	247
6	155
7	221
8	307
9	201
0110	341
1	221
2	141
3	202
4	133
5	266
6	100
7	022
8	202
9	222
0120	273
1	241
2	322
3	247
4	177
5	221
6	307
7	330
8	122
9	221
0130	163
1	372
2	363
3	266
4	002
5	316
6	363
7	373
8	023
9	371
0140	053
1	372
2	043
3	363
4	360
5	024
6	316
7	363
8	373
9	370
0150	203
1	032
2	266
3	220
4	364
5	201
6	265
7	273
8	361
9	321
0160	360
1	026
2	201
3	273
4	201
5	267
6	201
7	267
8	050
9	361
0170	030
1	360
2	335
3	335
4	346
5	260
6	254
7	032
8	156
9	123
0180	371
1	201
2	275
3	347
4	347
5	347
6	026
7	365
8	345
9	326
0190	365
1	223
2	374
3	201
4	203
5	360
6	314
7	221
8	353
9	203
0200	021
1	203
2	003
3	243
4	322
5	202
6	000
7	146
8	221
9	214
0210	267
1	367
2	321
3	273
4	350
5	331
6	222
7	102
8	272
9	046
0220	271
1	330
2	372
3	371
4	
5	143
6	136
7	052
8	030
9	330
0230	122
1	221
2	253
3	201
4	203
5	033
6	127
7	266
8	077
9	317
0240	154
1	120
2	155
3	121
4	156
5	132
6	157
7	133
8	147
9	373
0250	322
1	334
2	036
3	372
4	221
5	027

Figure 17 RAM Driver Routine Code Listing (Sheet 1 of 3)

D

COLUMN 22

CARD 1 SIDE B

Step	Code
6	127
7	153
8	137
9	152
0260	136
1	141
2	135
3	140
4	134
5	147
6	371
7	266
8	077
9	317
0270	373
1	322
2	030
3	372
4	242
5	026
6	330
7	126
8	203
9	003
0280	243
1	063
2	203
3	021
4	373
5	322
6	056
7	032
8	373
9	252
0290	045
1	222
2	040
3	372
4	202
5	000
6	023
7	360
8	326
9	263
0300	001
1	325
2	221
3	214
4	
5	
6	
7	267
8	367
9	321
0310	202
1	104
2	203
3	021
4	273
5	350
6	331
7	330
8	333
9	127
0320	111
1	111
2	223
3	012
4	050
5	322
6	115
7	325
8	266
9	353
0330	325
1	272
2	060
3	271
4	170
5	372
6	271
7	132
8	372
9	371
0340	360
1	314
2	202
3	216
4	266
5	217
6	271
7	020
8	317
9	202
0350	366
1	201
2	203
3	201
4	332
5	203
6	051
7	122
8	151
9	203
0360	051
1	223
2	043
3	203
4	111
5	321
6	266
7	100
8	022
9	203
0370	211
1	266
2	217
3	317
4	143
5	136
6	203
7	063
8	273
9	256
0380	032
1	273
2	251
3	202
4	311
5	143
6	136
7	266
8	060
9	202
0390	366
1	050
2	202
3	311
4	266
5	001
6	202
7	366
8	266
9	077
0400	317
1	371
2	203
3	211
4	273
5	256
6	032
7	273
8	251
9	203
0410	146
1	145
2	124
3	042
4	240
5	244
6	203
7	063
8	222
9	246
0420	143
1	136
2	050
3	042
4	267
5	001
6	022
7	203
8	146
9	202
0430	216
1	156
2	123
3	203
4	111
5	322
6	251
7	275
8	273
9	361
0440	322
1	244
2	221
3	223
4	276
5	202
6	013
7	305
8	202
9	361
0450	202
1	362
2	304
3	304
4	334
5	252
6	350
7	360
8	365
9	322
0460	023
1	266
2	300
3	315
4	202
5	362
6	043
7	343
8	343
9	023
0470	315
1	266
2	003
3	202
4	366
5	364
6	340
7	242
8	300
9	364
0480	360
1	315
2	202
3	362
4	222
5	315
6	
7	
8	266
9	300
0490	202
1	361
2	202
3	364
4	202
5	364
6	360
7	315
8	202
9	364
0500	371
1	
2	021
3	360
4	061
5	346
6	251
7	371
8	371
9	203
0510	003
1	263

Figure 17 RAM Driver Routine Code Listing (Sheet 2 of 3)

COLUMN 23 CARD 2 SIDE A

Step	Code
2	010
3	321
4	371
5	272
6	076
7	271
8	360
9	322
0520	371
1	
2	266
3	060
4	021
5	201
6	076
7	221
8	002
9	146
0530	352
1	352
2	352
3	266
4	241
5	324
6	126
7	371
8	266
9	263
0540	025
1	360
2	026
3	266
4	371
5	027
6	371
7	301
8	241
9	056
0550	202
1	013
2	301
3	353
4	353
5	353
6	256
7	057
8	371
9	350
0560	352
1	223
2	054
3	273
4	251
5	033
6	273
7	361
8	203
9	102
0570	336
1	203
2	102
3	273
4	365
5	203
6	102
7	336
8	322
9	073
0580	323
1	334
2	073
3	321
4	371
5	330
6	127
7	273
8	272
9	033
0590	050
1	322
2	073
3	321
4	073
5	110
6	334
7	252
8	131
9	223
0600	117
1	127
2	053
3	322
4	021
5	273
6	255
7	371
8	075
9	334
0610	334
1	075
2	223
3	340
4	360
5	021
6	330
7	266
8	345
9	325
0620	040
1	263
2	100
3	317
4	266
5	200
6	346
7	251
8	162
9	202
0630	013
1	304
2	127
3	146
4	167
5	111
6	255
7	201
8	202
9	013
0640	306
1	254
2	213
3	371
4	375
5	266
6	200
7	223
8	204
9	203
0650	032
1	272
2	023
3	271
4	205
5	035
6	040
7	263
8	100
9	317
0660	266
1	200
2	202
3	366
4	272
5	023
6	271
7	140
8	035
9	223
0670	235
1	273
2	267
3	032
4	330
5	331
6	336
7	336
8	203
9	146
0680	330
1	266
2	251
3	325
4	341
5	261
6	253
7	127
8	146
9	111
0690	255
1	270
2	142
3	254
4	170
5	371
6	202
7	013
8	302
9	
0700	
1	
2	330
3	127
4	273
5	272
6	033
7	272
8	060
9	271
0710	306
1	372
2	050
3	371
4	325
5	376
6	376
7	376
8	046
9	343
0720	343
1	026
2	202
3	364
4	302
5	343
6	367
7	267
8	300
9	372
0730	203
1	374
2	373
3	026
4	266
5	200
6	375
7	266
8	344
9	327
0740	344
1	260
2	312
3	042
4	246
5	354
6	046
7	315
8	046
9	321
0750	360
1	026
2	334
3	252
4	365
5	223
6	324
7	040
8	267
9	277
0760	317
1	373
2	223
3	143
4	273
5	351
6	372
7	371

Figure 17 RAM Driver Routine Code Listing (Sheet 3 of 3)

D

Appendix E

HOW TO BYPASS THE DE-SELECTION OF PERIPHERALS

Until now, the off-page branch instructions given for manual or programmable operations have caused the interface routines to "deselect" (or avoid) peripherals other than the 392 RW Interface when information was being transmitted from the 392 RW to the 1800. The reason for this is clear if we consider the garbled output that would result if the data passed through a slower peripheral, such as an I/O Writer, on its way to the 1800. The I/O Writer would not be able to interpret the data as fast as the 392 was sending it.

Other peripherals can operate simultaneously with the 392 RW. An output control byte (OPCB) and an identifying device code are used to select and control the peripherals. The 392 RW Interface is controlled by Flag Group B lines, and responds to Flag Group B instructions whenever the selected 392 is in the READY state. It also responds to any OPCB by terminating any tape operation which may be in process.

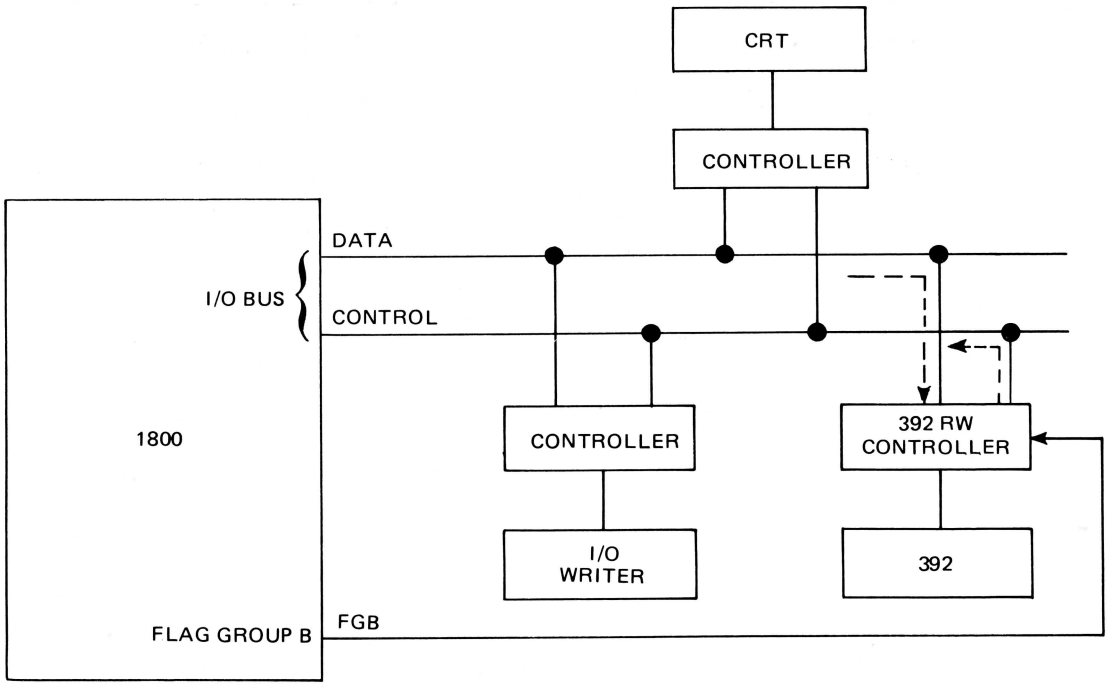


Figure 18 Data Flow from 392

Peripherals are controlled by appropriate OPCB's and the 392 RW is controlled by Flag Group B outputs. Output data from the 1800 takes the normal I/O interface path ($\overline{\text{BYOT}}$); input data does not use the normal path (BYIN) but is handled via status and external interrupt lines ($\overline{\text{INT2}}$, $\overline{\text{INL8}}$, $\overline{\text{INH1}}$, $\overline{\text{INH4}}$).

E

De-selection of peripherals is accomplished by clearing the index register (CLIX) and outputting a control byte (OPCB). To operate a fast peripheral simultaneously with a tape operation, these codes must be omitted. This may be desirable in the case where a CRT is connected to the 1800 I/O bus. The CRT could display data as it is being read into the calculator rather than waiting for the calculator to re-transmit the data.

To bypass the de-selection of peripherals, the off-page branch instructions must be altered for both manual operations and automatic programmable operations. The changes affect the LDDL instruction as follows:

Manual Operation		Programmable Operation	
LDDH	272	LDDH	272
CCC	070	CCC	070
LDDL	271	LDDL	271
RRB	002	RRB	351
STKD	372	STKD	372
RCLP	371	RCLP	371
RCLP	371	RCLP	371

SUMMARY OF 392 TAPE DRIVE OPERATIONS

Preconditioning Tape

Load the Tape Preconditioning Routine at BRANCH 00.
Touch JUMP, SYMB, 0, RESUME.
Enter the number of blocks to be written (150 maximum) per side.
Touch RESUME again.

Accessing Manual Operations

At a convenient jump point load the following codes for an off-page branch to the Manual Operations Routine:

MODE	KEY CODE	MNEMONIC
RUN	JUMP XX	JUMP XX (Step XXO)
LOAD	066	SYMB
	012	•
	272	LDDH
	070 (if ROM Driver) or 021 (if RAM Driver)	COL
	271	LDDL
	000	REG/BYTE
	372	STKD
	272	LDDH
	076	COL
	271	LDDL
	340	BYTE
	322	RCID
	240	JIL1
	XXX	XXX
	371	RCLP
	371	RCLP

RUN: Now touch JUMP, SYMB, •, RESUME
followed by BL.CCRRBΦN

Block — Col. Reg. Byte — Special Function 0–5

F

Manual Operations

Port	Keyboard Sequence Block.Address	Special Function*	Description
READ/WRITE	BL.CCRRB	Φ 0	Write 256 bytes onto block BL, start at column CC register/byte RRB. Link bit is reset, this block not linked to next block.
	BL.CCRRB	Φ 1	Write 256 bytes onto block BL and set link bit so next block will follow into memory when tape is being read. Start at column CC register/byte RRB.
	BL.CCRRB	Φ 2	Read block BL from tape into memory starting at column CC, register/byte RRB. If block BL was written with a Φ1 command, block BL + 1 will be read into column CC + 1. Blocks continue to be read in this fashion until a block written with a Φ0 command is encountered.
	BL	Φ 3	Read block BL from tape into the address specified by the address bytes on the tape. Linked blocks will be loaded according to their respective addresses.
READ	BL.CCRRB	Φ 4	Same as Φ2 except computer reads from tape drive connected to READ port.
	BL	Φ 5	Same as Φ3 except computer reads from tape drive connected to READ port.

*On Models 1810 and 1830 use □ instead of Φ.

Programmable Operations

For automatic tape manipulation under program control load the following program steps:

BL.CCRRB	(Block BL, Column CC, Register RR, Byte B)
BRXX	Branch to column XX in program memory
YYZ	Enter code for register YY byte Z
OON	Enter N, the number from 0 to 5 of the special function desired

At the decimal step equivalent to octal address XX/YYZ load the following:

KEY CODE	MNEMONIC
272	LDDH
070 (if ROM Driver) or 021 (if RAM Driver)	COL
271	LDDL
301	REG/BYTE
372	STKD
371	RCLP
371	RCLP

Appendix G

PREPARING CASSETTE TAPES

Any cassette tape prepared by Monroe must contain the RAM version of the 392 Driver Routine on the first three blocks. A magnetic card containing a 392 Accessing Routine will be loaded by the user; this routine will allow the RAM Driver Routine to be read into the calculator if it is needed. The code listing for card sides A and B of the 392 Accessing Routine is given in Figure 19.

To prepare a 392 cassette tape proceed as follows:

- Write the RAM version of the 392 Driver Routine on magnetic cards as explained in Appendix D. Press [↓000] [3] [2] and load the cards into the reader in the same sequence as recorded.
- Press [JUMP 00] [0] [0] to jump to step 000 (or jump to any convenient address).
- Switch to the LOAD position and enter the following codes:

CODE	MNEMONIC
066	SYMB
012	•
272	LDDH
021	CCC
271	LDDL
000	RRB
372	STKD
371	RCLP
371	RCLP

- Switch to the RUN position and press [JUMP 00] [IND SYMB] [•] [RESUME] (the 392 Manual Tape Commands may now be used).
- Place a preconditioned tape in the drive connected to the 392 RW Interface READ/WRITE port. Preconditioning is explained on page 3-3.
- Press [1] [•] [2] [1] [Φ] [1] to write the contents of column 21 into block 1 and set the link bit. The next block number 2.00 is printed.
- Press [2] [•] [2] [2] [Φ] [1] to write the contents of column 22 into block 2 and set the link bit. The next block number 3.00 is printed.
- Press [3] [•] [2] [3] [Φ] [0] to write the contents of column 23 into block 3 and reset the link bit. The next block number 4.00 is printed.
- The RAM Driver Routine is now recorded on tape blocks one through three. The remaining blocks may be used for duplicating other programs.

| STEP | CODE | | |

Model 392 Read/Write

TAPE CASSETTE DRIVE SYSTEM

for 1800 Series Calculators

Litton MONROE

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